



Jones, E. T., Hewlett, R., & Mackay, A. W. (2021). Weird weather in Bristol during the Grindelwald Fluctuation (1560-1630 CE). *Weather*, 76, 104-110. <https://doi.org/10.1002/wea.3846>

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Weird weather in Bristol during the Grindelwald Fluctuation (1560–1630)

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The thirteenth to the nineteenth centuries witnessed a series of wide-scale climatic deteriorations, commonly known as the ‘Little Ice Age’, which resulted in the lowest temperatures experienced globally for the whole of the Holocene (past 11 700 years) (Matthews and Briffa, 2005; Marcott *et al.*, 2013). The Grindelwald Fluctuation (1560–1630 CE) is the name given to a pronounced cooling phase within this era, taking its name from the long-observed advance of the Swiss Grindelwald Glacier during the late sixteenth and early seventeenth centuries. This glacial advance has been ascribed, along with many other indicators of falling temperatures, to a phase of global cooling exacerbated by huge volcanic eruptions at Colima, Mexico (1585); Nevado del Ruiz, Columbia (1595); and Huaynaputina, Peru (1600) (Toohey and Sigl, 2017; Degroot, 2018).

The decades of the Grindelwald Fluctuation encompassed some of the ‘worst’ weather of the last millennium. A series of cold and wet summers in the 1590s was associated with the last major famine in England, while in many other parts of the world, poor weather, aggravated by political crises, resulted in mass starvation (Clark, 1985; White, 2011; Parker, 2018). Matters did not improve markedly over the following decades: Parker (2013) argued for a ‘General Crisis of the seventeenth century’ as crop yields fell and rulers struggled to raise revenues from their people.

As concerns about global warming continue to rise in the twenty-first century, climate scientists have put considerable effort into reconstructing past climatic change (Masson-Delmotte *et al.*, 2013). To understand how the world’s climate might further change in the future, it is useful to know how and why it changed in the past. The problem

for scientists is that accurate and systematic weather recording only goes back a few hundred years, even in Britain, and for much of the world, such weather records have only been kept since the twentieth century. For earlier periods, scientists thus rely on paleo-environmental evidence retrieved from stratified deposits, such as ice cores, and marine and lake sediments. Paleotemperatures from these deposits can be derived from microfossils, such as pollen and foraminifera, or from the ratios of specific elements and isotopes. Alternatively, very high-resolution climate records can be derived from ‘natural archives’ that consist of annually resolved records, such as tree rings, to assess weather conditions within a given year. With data from such sources, it is possible to learn much about changing environmental conditions on an annual, or even seasonal, basis – albeit the reconstructions often disagree in absolute terms (Masson-Delmotte *et al.*, 2013).

While most paleo-environmental reconstruction has been generated by scientists, environmental historians have shown that they too can throw light on climatic change and the impact of the weather on human societies, particularly for the sixteenth to nineteenth centuries. For example, Degroot (2018, pp. 27–31) used weather records from ships’ logbooks to assess the nature and impact of climate change in the Dutch Republic during the seventeenth century. His work suggests that the Grindelwald Fluctuation not only led to a general cooling, it was also associated with increased storminess and more unsettled weather. Meanwhile, a recent article on the ‘Great Snow’ of 1614/1615 (Veale *et al.*, 2018) has shown that a multi-source approach can be used to build up a sophisticated picture of the nature, location and impact of exceptional weather events during the early seventeenth century.

The current article presents evidence from a documentary source that casts light on exceptional weather events during the Grindelwald Fluctuation. All the material comes from three Bristol chronicles/annals. These chronicles recorded matters of note in the city and are identified here as ‘Ricart’, ‘Adams’ and ‘Anon. Bristol’. At this time, Bristol was the second port of the realm and one

of the three largest cities in England, with an extensive overseas trade connecting it to Ireland, France, Spain and Portugal (Lobel and Carus-Wilson, 1975; Stone, 2011). The city’s strong and independent identity was reflected, among other things, by a chronicle-writing tradition that continued until the early nineteenth century (Sweet, 1997). The first two chronicles used here are well known. Ricart’s was the official municipal ‘calendar’, kept by the town clerk from 1479 (Ricart and Toulmin Smith, 1872). While it contains some references to weather events, the chief focus was civic and political matters. Adams’s chronicle is based on a manuscript compiled by William Adams of Bristol during the 1630s (Adams and Fox, 1910) and references some major weather events. The third chronicle (Anon. Bristol, n.d.) has not been published. While it has been in the care of Bristol Archives since 1931, its fragile state meant that access was only granted recently to allow it to be photographed and transcribed (Jones, 2019; Figure 1). The chronicle is written in at least three different hands and seems to have been compiled over the course of the late seventeenth to early eighteenth centuries. In common with other chronicles, its Tudor and Stuart entries would have drawn on information taken from earlier annals, now lost. For present purposes, the chief interest of the chronicle is that it contains many entries that discuss severe weather events in the city – particularly for the period 1560–1630.

The Bristol chronicles record unusual weather events that caught the attention of the chroniclers: severe floods, extreme frosts, destructive storms, droughts, unseasonal blizzards and poor summer weather that led to food shortages. The entries suggest that Bristol’s weather during the Grindelwald Fluctuation was not just cold – it was highly erratic, resulting in a series of extremely destructive weather events. These included the famine years of the 1580s and 1590s, the Great Flood of 1607 and the Frosts of 1564/1565 and 1607/1608. The following section reproduces some of the accounts from the chronicles that relate directly to weather events or those that can be assumed to have resulted from poor weather – such as harvest failures and

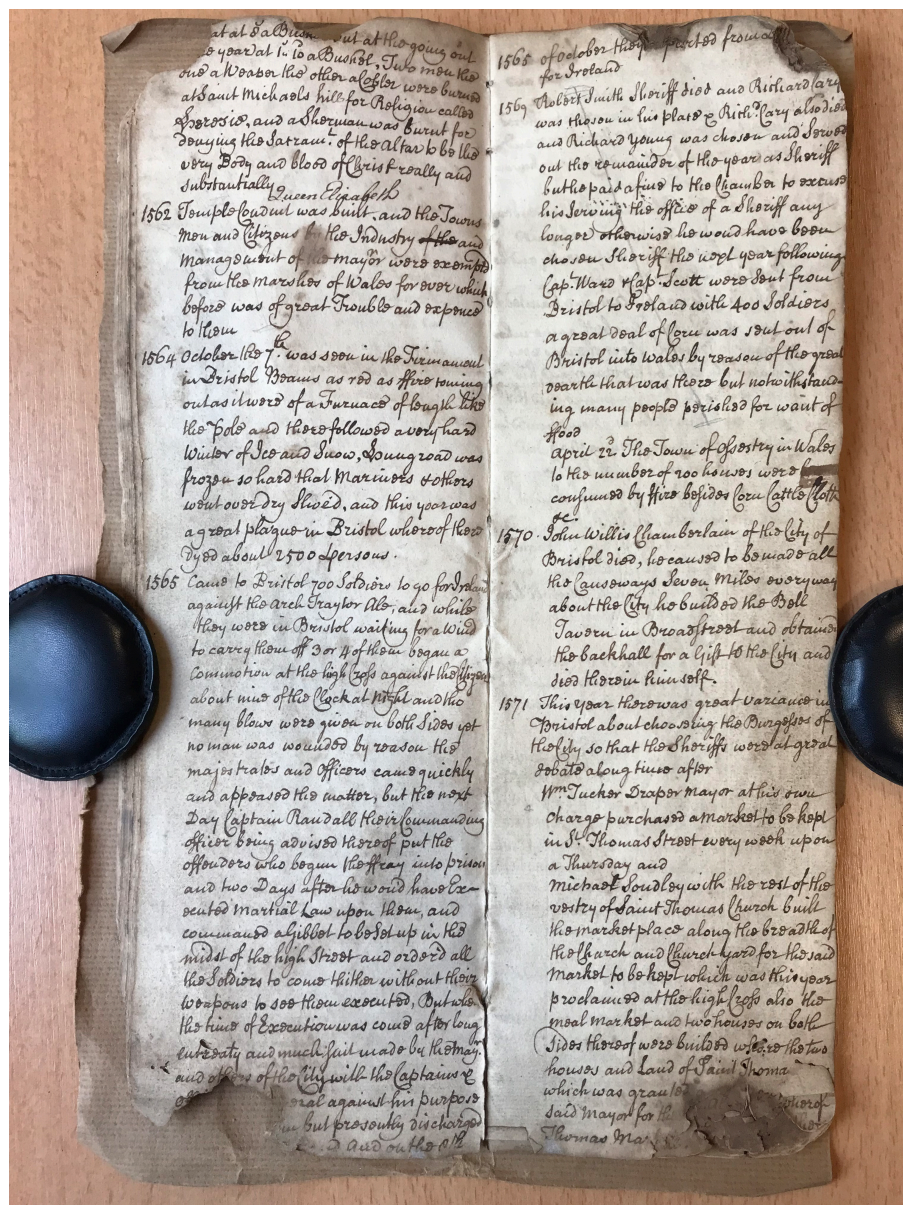


Figure 1. Part of the 'Anonymous' chronicle, 1557–1571 (Bristol Archives, 09594/1).

spikes in the price of grain. As with all such chronicles or annals, the entries are listed by year. There was usually no attempt to provide an overarching narrative or to relate the events of a given year either to other entries recorded that year or to the events of different years.

Extracts from the three chronicles¹

Winter 1564/1565 (Anon. Bristol)

October the 7th [1564] was seen in the firmament² in Bristol beams as red as fire coming out as it were of a furnace of length

¹Spelling, capitalisation and punctuation modernised. All dates are 'old style'. New style dating (following Britain's adoption of the Gregorian calendar in 1752) would be 10 days later.

²The sky or heavens. The phenomenon described is presumably the *aurora borealis*.

like the pole and there followed a very hard Winter of ice and snow, Hungroad³ was frozen so hard that mariners & others went over dry shod.

29 September 1568–28 September 1569 (Anon. Bristol)

A great deal of corn was sent out of Bristol into Wales by reason of the great dearth that was there but notwithstanding many people perished for want of food.

29 September 1584–28 September 1585 (Anon. Bristol)

Wheat sold in Bristol at 7s. per bushel and all other grain very dear. But for relief the

³An area of the River Avon, 4 miles downriver from Bristol and about a mile from its confluence with the Severn Estuary. The Hungroad was a regular anchorage within the outer port of Bristol (Figure 2).

Commons begun to make an insurrection. The mayor wisely pacified them and caused the Pensford⁴ bakers to come into the city with bread every day in the week and the Mayor caused and procured corn to come from Danzig⁵ to Bristol whereby great store of rice⁶ came hither as was sold at 4s. per bushel until Michaelmas. The Spring tide did rise so high at Saint David's Flood⁷ [.....] broke in the Sea and did much [.....] City and in Wales.

29 September 1596–28 September 1597 (Anon. Bristol)

A great famine in divers places and in the city of Bristol all kinds grain was very dear so that the poor was in very great want... wheat at 20s. per bushel malt at 8s., rye at 10s. but Danzig rye at 5s. 8d.

4–8 October 1603 (Ricart and Toulmin, pp. 63–64)

This year upon the fourth of October was the greatest snow that ever was known by the memory of man, which continued four days. And by reason that the leaves were then upon the trees, very many trees of all sorts, especially of fruit trees, were thrown down by the roots, and the limbs and boughs of many others were broken in pieces.

20 January 1607⁸ (Anon. Bristol)

January 20th: in the morning being Tuesday at high water there arose such a high flood that the sea drove over the banks and drowned all the marsh country in Wales and on the English coasts. It drowned the cattle and carried away the corn and hay, and the people to save themselves climbed upon the tops of houses and trees, and it did carry away many houses and trees and many people were drowned the flood came on so fast. It came so fast & high at Henbury⁹ that the waters continued a long time a fathom deep that the people were obliged to abide on the trees two or three days. And this mayor Mr Barber hearing of their distress commanded cock-boats¹⁰ to

⁴A large village 7 miles south of Bristol.

⁵The Hanseatic port of Gdańsk, Poland.

⁶This may be a transcription error on the part of the chronicler, 'rye' being more probable.

⁷It seems possible the chronicler meant to write Saint David's Head – a well-known navigation point in Pembrokeshire, Wales. Unfortunately, part of the entry has been damaged.

⁸Ricart contains an independent but compatible account of the flood, which suggests that the inundation was caused by 'the wind blowing hard at south-west', p. 183.

⁹The large parish of Henbury covered a considerable area of low-lying coastal land.

¹⁰A small rowing boat. Adams gives the mayor's name as Barker.

be hauled thither to fetch the people that were on trees that they might not perish with cold and hunger. And in the city of Bristol all the lower part were drowned about 4 or 5 foot so that a boat of about five tons came up to Saint Nicholas crowd door.¹¹ The boatman put his boathook against the lower step and thrust off his boat again. The Waters were up in Saint Stephen's, Saint Thomas and Temple churches halfway up the seats. And the Bridge arches were stopped so that the water buoyed up higher towards Temple and Redcliff sides than in any other parts which at the return it brought down the river great trees but did not hurt the Bridge. The merchants received great losses in their storehouses and cellars by it.

20 November 1607–8 February 1608
(Anon. Bristol)

November the 20th 1607 began a frost which lasted till the 8th February following at which time the River of Severn and Wye were so hard frozen that people did pass on foot from side unto the other and played gambols¹² and made fires to roast meat upon the ice. No long trows¹³ etc could come to Bristol and when the ice broke away there came swimming down with the current of the tide great massy flakes of ice which endangered many ships that came up the [Bristol] Channel into Kingroad.¹⁴ The continuance of the frost starved a great number of birds, and made corn sell very dear.

1608–1609 (Anon. Bristol)

This year there was a great dearth throughout the Realm and many people perished for want of food. But the Lord in his mercy supplied our scarcity with store of corn brought from foreign parts.

Winter 1610/1611 (Anon. Bristol)

The winter proved very stormy in so much that it occasioned the greatest shipwrecks that ever was known in England. And in Kingroad near Bristol a great Flemish ship that came from the Indies richly laden with

spices and other rich commodities was cast away in sight of the point, she divided in two, one half part remained in the place and the other half drove up the stream towards Aust passage.¹⁵ And the men were all drowned by reason of the storm which happened on the 24th October [1610] on Wednesday about 4 of the clock in the afternoon, she coming up the River.

May–August 1611 (Adams and Fox, p. 187)

This year from May to August, being 4 months, was the driest time that any man then living ever knew, for all the grass was starved and dried up like ground new tilled, which starved many cattle, and had starved more but it pleased God to send a mild and warm winter to make amends.

Winter 1612/1613 (Anon. Bristol)

The winter proved very hard and stormy that it shook most of the houses in the City of Bristol and caused great shipwrecks in diverse places.

¹⁵The ferry crossing between Aust and Beachley, 8 miles upriver from Avonmouth.

1613–1614 (Anon. Bristol)

And this year there was a great scarcity of corn, there came to Bristol from France, Denmark and other places from September 1613 to June 1614 of ships and barges to the number of 104 with wheat, rye and barley 25 105 quarters.¹⁶

1623–1624 (Adams and Fox, p. 213)

This winter fell out extreme cold and frosty, with such store of snow that many fowl and cattle died for want of sustenance: which cold lasted until May [1624]; and the summer after that proved very dry; grass and hay was very scant, and water failed in many places, whereby cattle were liken to starve again in many places.

Summer 1626 (Adams and Fox, pp. 216–17)

Concerning famine or dearth of corn we stood in much fear this year for all this summer proved very wet and stormy, that corn could not ripen but was beat down in many places; insomuch that famine must have followed by the judgement of all men,

¹⁶This is about 5000 tons.

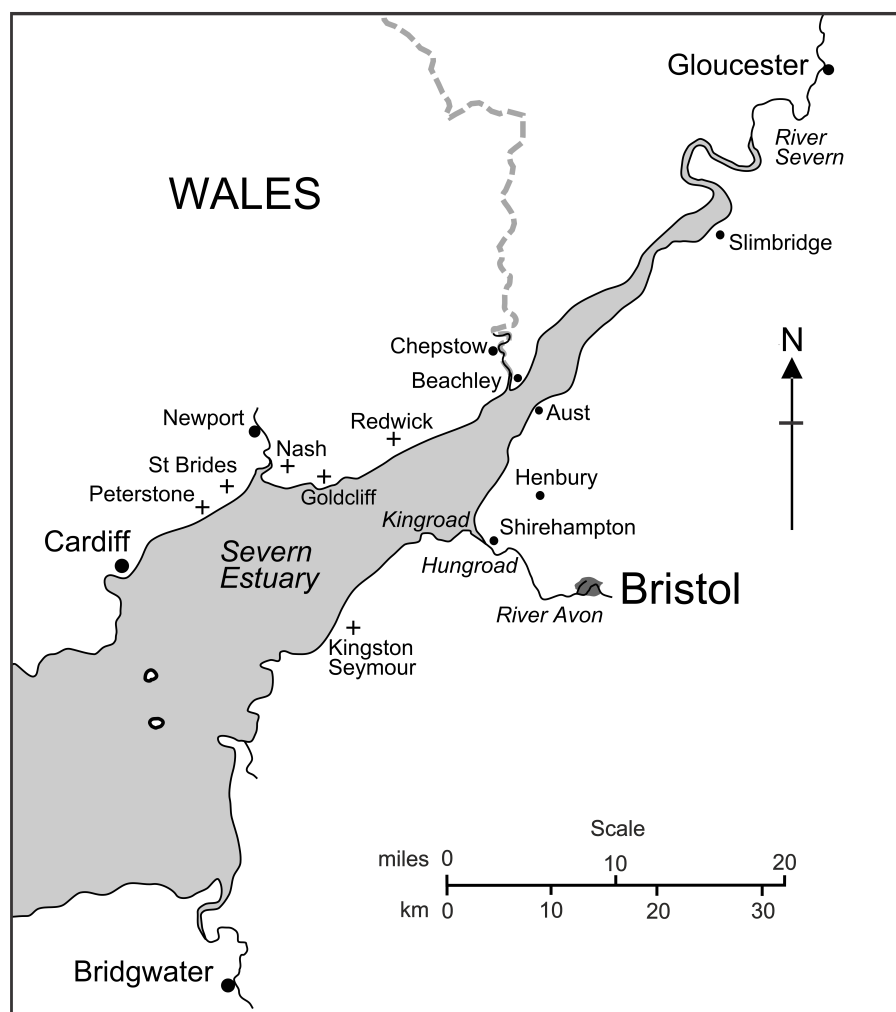


Figure 2. Map of Bristol and the Severn Estuary.

¹¹Crowd: the church crypt. The road gradient and level beside St Nicholas were greatly altered during the rebuilding of Bristol Bridge (opened 1768). The bottom of the crowd door is now c. 2m below street level, and the lower step must have been below that: Rose Hewlett, 'The 1607 Severn Estuary flood: A true report' (forthcoming doctoral thesis, University of Bristol). A boat of five tons would be one capable of carrying five tons of cargo.

¹²To leap or caper.

¹³A flat-bottomed cargo boat widely used on the rivers Severn and Wye.

¹⁴A bay and anchorage in the Bristol Channel between Avonmouth and Portishead (Figure 2).

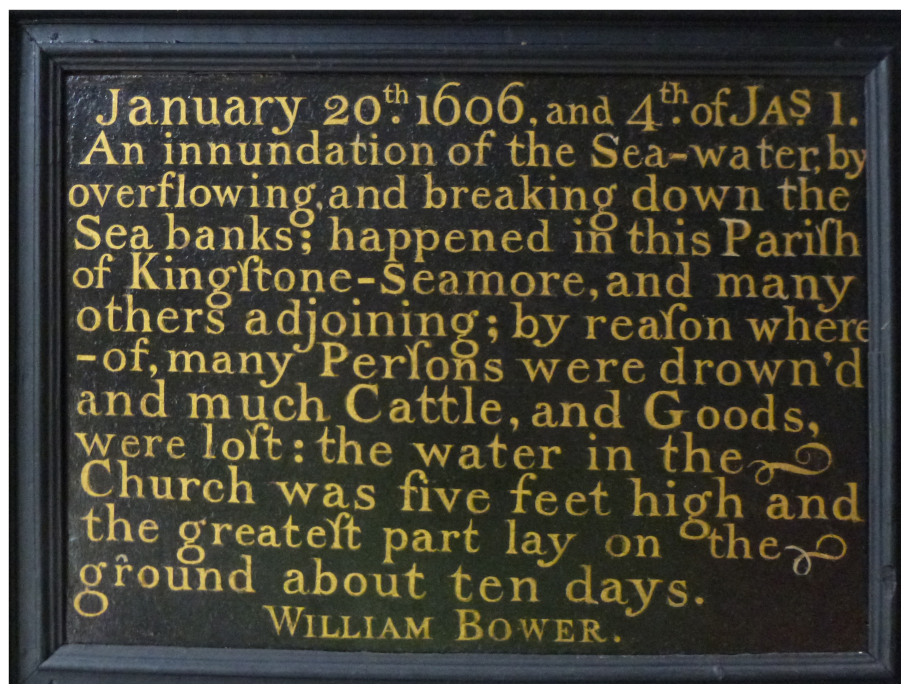


Figure 3. The Great Flood memorial in Kingston Seymour church, Somerset, recorded here as 1606 because the year was typically believed to begin on 'Lady Day' (25 March).

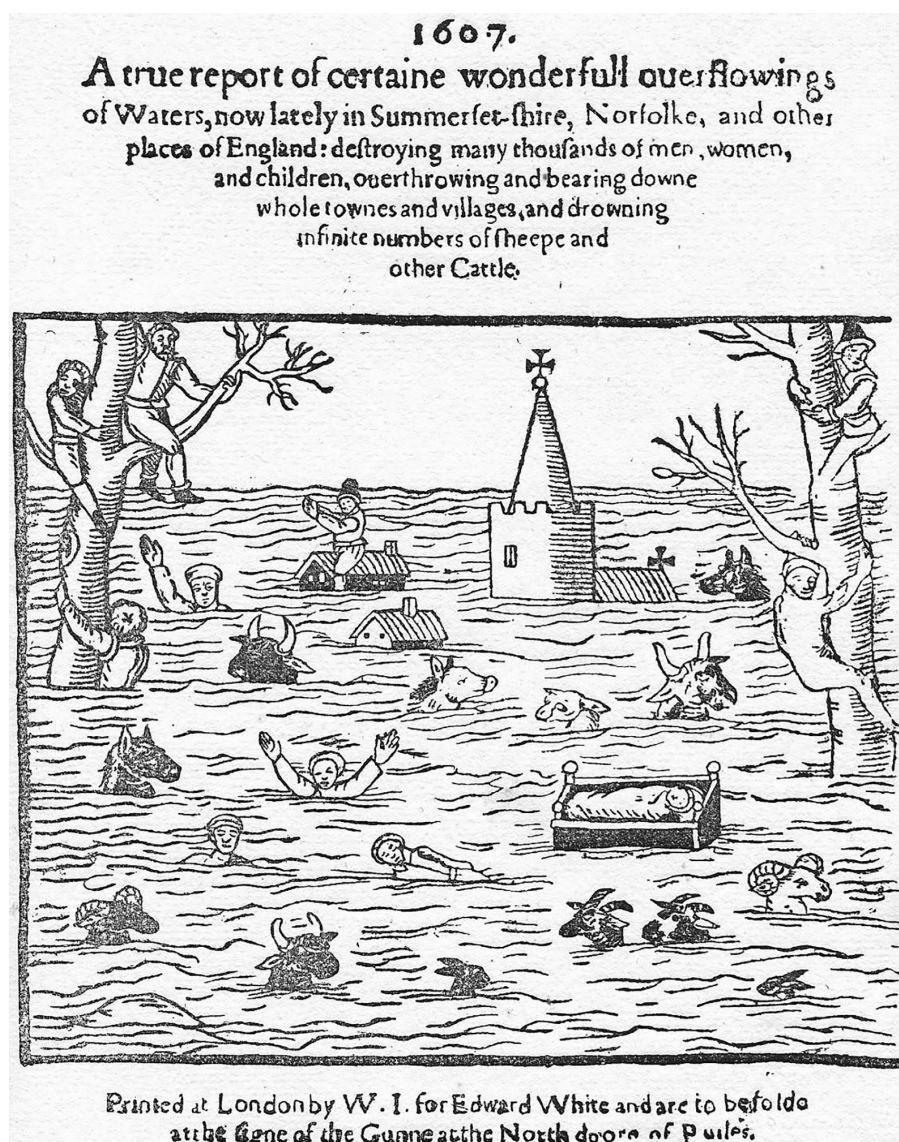


Figure 4. Facsimile of the title page of *A true report*, Ernest. E. Baker (Weston-super-Mare Gazette, 1884).

if God had rained down His anger a little longer upon the fruits of the earth.

These entries suggest that the period included some awful weather. But what can be read from them? Are they reliable? How useful are they for understanding the weather of the period?

First, the entries do not record the weather in a systematic manner: they do not record *all* the weather, only events that the chronicler thought noteworthy. They also do not record the weather using an objective measurement system for temperature, precipitation or wind speed. On the other hand, the records are not merely impressionistic. The annalists sought to record the extent and significance of events in relative terms. Stating how the high the flood waters rose in 1607, or the extent of riverine freezing in 1564/1565 and 1607/1608, provided a yardstick for comparing weather events. Moreover, the descriptions, in at least some instances, can be corroborated from independent sources. The Gloucestershire Court of Sewers held jurisdiction over sea defence and land drainage mechanisms, and its records for 1607 reveal the extent of tidal flooding between Shirehampton (on the Bristol Avon) and Slimbridge (Gloucestershire) and also the condition of the sea walls before and after the event (Hewlett, 2020). This evidence supports the annalist's description of the severity of the flood from a local perspective, and surviving flood markers in churches bordering the Severn Estuary (Figures 2 and 3) confirm that the height of the inundation has not been exceeded.¹⁷ The 1607 flood and the storms of 1612/1613 were also reported in London news pamphlets (Figure 4), albeit in more sensational terms (Anon., 1607; Jones, 1607; Anon., 1613a,b. Similarly, the great frosts of 1564/1565 and 1607/1608 are discussed in a 1608 pamphlet, the second freeze including the holding of the first known 'Frost Fair' on the River Thames at London (Anon., 1608; Figure 5). In Bristol itself, the 'grete freese' of February 1565 resulted in the loss of water supply to the city, while from Christmas 1607 to early January 1608, the Mayor of Bristol was forced to spend much money on ice clearance.¹⁸ Again, in this context, the annalist's account of the freeze in Bristol seems balanced and fact-based. However, crosschecking has also revealed a few instances in which the year of an event has been recorded incorrectly in an annal, the true date being either

¹⁷At Peterstone, St Brides Wentlooge, Nash, Goldcliff and Redwick (Gwent) and Kingston Seymour (North Somerset).

¹⁸In February 1565, the 'Key Pipe' froze (supplying water to the quay head), and building work ceased due to the 'grete freese': Bristol Archives, F/Au/1/9, pp. 36, 39. From Christmas 1607 to early January 1608, there are numerous payments relating to ice clearance in the city: Bristol Archives, F/Au/1/16, pp. 209–210.

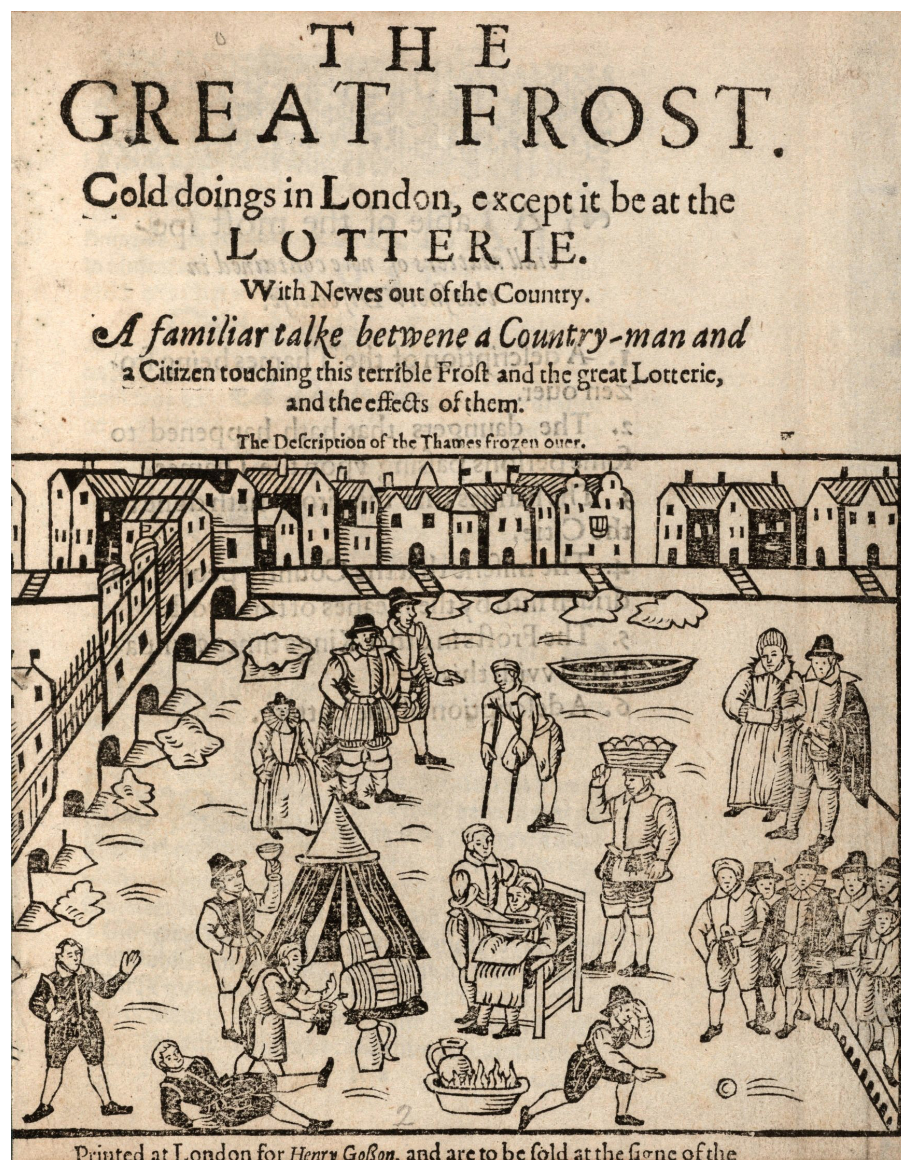


Figure 5. Depiction of London's 'Frost Fair' held on the River Thames, 1608. Taken from the cover of Thomas Dekker's news pamphlet, *The Great Frost* (1608).

a year earlier or later. For instance, the great freeze of 1564/1565 is recorded under '1564', which would imply that the freeze occurred in 1563/1564 (Anon. Bristol). This is most likely because of the use of alternative calendaring systems at this time, which can cause confusion, even for modern historians.¹⁹

The approach taken by Bristol's annalists is mirrored in their discussions of other catastrophic events in the city. The death toll from plague outbreaks, for instance, was based on an analysis of Bristol's parish burial registers and Bills of Mortality (Adams and Fox, 1910, p. 64).²⁰ Similarly, the figures relating to grain imports to relieve famine were said to have

¹⁹The Bristol annals normally took Michaelmas (29 September) as the start of the year, this being when the mayor and sheriffs commenced office. The year referred to in the annals is usually the year in which the mayor etc. ended their year-long term.

²⁰The death toll from the 1603–1605 plague outbreak was said by Adams to be 'according to the church books and printed tickets'.

been extracted from the city's port books (Adams and Fox, 1910, p. 201).²¹ The source of the grain price data is not mentioned but was presumably derived from the commercial records of the merchants who dominated the city. Indeed, the approach in the Bristol annals shows more attention to detail, evidence and sources than many 'histories' of this period. Such an emphasis on factual reporting probably reflects the culture of an intensely commercial port city, whose overseas merchants depended on accurate and impartial intelligence to make a living.

If the accounts provided in the annals were generally accurate, they were not complete. They reveal that people in the period followed weather patterns closely. Yet the job of an annalist was not to record all weather events, or even all exceptional weather events. Each chronicler recorded what he or she felt to be the most noteworthy events of a given year. That meant the degree of weather reporting depended on what else was happening at the time.

A good example of this is the failure of the 'Anonymous' chronicle to record the great snowfall of 4–8 October 1603, which destroyed so many fruit trees in the city. This omission can be ascribed to the annalist's decision to focus instead on a terrible plague outbreak, which killed 2600 people in Bristol between 18 July 1603 and February 1605. Given that this epidemic wiped out about a fifth of the city's population in just 18 months (Slack, 1977, p. 51), the chronicler's focus does not seem unreasonable. More generally, too much should not be read into the fact that the extant Bristol chronicles have fewer weather entries for both the decades before 1560 and for those after 1640. It is possible that there were fewer extreme weather events before and after the Grindelwald Fluctuation. Yet it would be unsafe to assume this from these surviving Bristol chronicles.

The entries for the late sixteenth and early seventeenth centuries suggest that the period was marked by many destructive weather events. Some of these, such as great frosts and harvest failures, can be linked directly with the global cooling detected by climate scientists. The storms of the early seventeenth century fit with evidence derived from the logbooks of Dutch mariners, which suggest that the period witnessed a general increase in storminess (Clarke and Rendell, 2007). Other entries seem to imply that the weather in the period was also simply extremely erratic, including prolonged droughts and unseasonal blizzards. That something odd had happened to the weather was certainly noticed by contemporaries, and not just in Bristol. In 1613, an anonymous London pamphleteer (Anon., 1613a; Figure 6) reflected that:

In this old, and last age of the World, we yearly behold the strange alterations of times & seasons...

*We have within these few years, as well within this our native country of England as in foreign nations, been most grievously stricken with the bitter blasts of powerful greatness, one while with the darts of death, as by plagues & pestilence, continuing long amongst us; another time by dry summers, and parching heats, droughts, & sweating sulphurs drying up the moistures of the earth, to cause barrenness with scarcity, then freezing and cold winters in more than usual extremity to annoy us; another time by floods and overflowings of waters breaking from the bounds of the Seas, in which merciless element many hundreds have perished and have lost both life and goods...*²²

²¹Many of the port books for Bristol still survive, and they do, indeed, record trade at a level of detail that would have allowed such calculations to be made: The National Archives, E 190 series.

²²Spelling modernised.

The last terrible Tempestious windes and weather.

Truely Relating many Lamentable Ship-wracks, with drowning of many people, on the Coasts of England, Scotland, France and Ireland: with the Isles of Wight, Garsey & Iarsey.

Shewing also, many great mis-fortunes, that haue lately hapned on Land, by reason of the windes and rayne, in diuers places of this Kingdome.



Imprinted at London for Iof: Hunt and are to be sold by Iohn Wright, 1613.

Figure 6. Depiction of the storms of 1612/1613. Taken from the London news pamphlet, *The last terrible Tempestious windes and weather* (1613). © British Library Board.

Taken in isolation, it would be easy to dismiss such statements as hyperbolic. The colourful language and providentialism of Jacobean news writers might make the modern reader suspect exaggeration. Yet the authors' observations should not be dismissed just because they interpreted these events as evidence of God's wrath with a sinful world. Both climate science and environmental history point to the Grindelwald Fluctuation being an age of extreme weather.

Links between anthropogenic climate change in the modern world and different types of extreme weather events are now well established (Coumou and Rahmstorf, 2012). This could increase the costs of weather-related hazards for about 350 million people across Europe in the coming decades, accompanied by a 50-fold increase in weather-related fatalities (Forzieri *et al.*, 2017). Such models fit with

anecdotal evidence that the world is already experiencing more extreme weather. Recent examples in the United Kingdom include the record temperature highs of December 2019 and the Severn Valley floods of February 2020.

The drivers behind the exceptional weather events recorded in the early modern Bristol chronicles and the London news pamphlets are different to today. During the Grindelwald Fluctuation, short-term forcing factors, such as volcanic eruptions, led to a more disturbed climate within the context of general global cooling. The economic, political and cultural context of the seventeenth century was also very different to that of the twenty-first century. This had a major impact on both the way severe weather was understood and the impact it had on contemporaries. Yet, despite these differences, the climate and weather of the early modern period provides a reminder of

how destructive climate change and severe weather can be in both the short and long term. For this reason alone, the period merits further research through multi-source and interdisciplinary approaches that can cast light on both individual weather events and their relationship to the causes and effects of climate change.

Acknowledgements

This research was carried out with the support of The Cabot Project (University of Bristol), funded by Gretchen Bauta, a private Canadian benefactor. For their comments and advice on earlier drafts of this paper, we thank Peter Coates, Margaret Condon, William Gilbert, Marianna Dudley and Bruce Campbell. The article is dedicated to Caroline Williams (1962–2019), founding Board Member of the Centre for Environmental Humanities, University of Bristol.

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doi: 10.1002/wea.3846